

Abstract

A steel powder metal skeleton is infiltrated with an infiltrant composition similar to the skeleton, with an additional agent that depresses the melting point of the infiltrant relative to the skeleton. Infiltration is driven primarily by capillary pressure. The powder and infiltrant compositions differ primarily only in a higher concentration of a melting point depressant agent "MPD" in the infiltrant. Carbon (C) and silicon (Si) and several other elements can be elements in an MPD, either alone or in combination. Certain steel target compositions are such that a complementary infiltrant, and skeleton can be chosen such that a skeleton will remain solid at an infiltration temperature at which the infiltrant can be melted and fully infiltrated, and further where there is a persistent two phase field, with a liquid phase that is large enough (greater than 7% vol, and typically between 20 and 40 vol%) so that flow can be maintained without choke off from diffusional solidification. The solid and the liquid phases remaining after any diffusional solidification have different compositions, with a bulk composition of the target. Typically the difference is slight, and the full part is substantially homogeneous. Heat treating, such as austenitizing, quenching, or slow cooling and tempering, can improve homogeneity and mechanical properties. The MPD can have a relatively high diffusivity and solubility in the skeleton. Methods of designing systems of target, skeleton and infiltrant compositions and infiltration temperature are disclosed.